10/578112
IAP12 Rec'd PCT/PTO 01 MAY 2006

[10901/126]

COAXIAL CABLE AND METHOD FOR ITS MANUFACTURE

The present invention relates to a coaxial cable, particularly for the shielded transmission of high-frequency signals, as defined in Claim 1, and a method for manufacturing such a coaxial cable as defined in Claim 8.

Coaxial cables are often used for transmitting high-frequency antenna signals in motor vehicles and are mostly used in large quantities in this application. A simple construction and a simple preparation are important factors for the cost-effective provision of corresponding coaxial cables.

Frequently, plug connectors are installed at the ends of the cable. In this connection, normally a strain relief must be provided, which protects the electrically effective contacts between the plug connector components and the wires against excessive mechanical tensile loads. For this purpose, crimp connections are frequently used, for example.

EP 0 118 168 A1 describes a plug connector for a multipole shielded cable, in which a sleeve for establishing contact with a braided shield is pushed into the interior of the tube-shaped braided shield. For mechanical fastening or for the purpose of strain relief, a crimp connection is produced by using another separate outer sleeve.

U.S. 4,131,332 describes a plug connector for a monopole coaxial cable, in which the shield in the form of a metal braid is also contacted on its inner side by a sleeve. Another sleeve is situated on the outside of the shield, which is to ensure a mechanical strain relief of the contact point by a crimp connection.

The previously known cables have, among other things, the disadvantage that they are comparatively expensive to produce and are made up of relatively many component parts.

The present invention is thus based on the objective of providing a coaxial cable, which can be produced at a low manufacturing expenditure, and which exhibits a high quality and robustness. The present invention also provides a cost-effective method for manufacturing and preparing such a coaxial cable.

This objective is achieved according to the present invention by the features of Claim 1 and Claim 8, respectively.

According to the present invention, a contact sleeve is pushed or inserted between a shield and a dielectric when attaching a plug connector that forms one end of a coaxial cable. For this purpose, the contact sleeve is situated in such a way that in one segment on the one hand it encloses the dielectric and one the other hand is enclosed by the shield. For the purpose of strain relief, an extrusion coating is performed. In this manner it is possible to do without a crimp connection or other additional measures of strain relief between the shield and the contact sleeve.

In a preferred refinement of the present invention, the outer contour of the extrusion coating exhibits different distances with respect to a core of the coaxial cable such that forces may be applied in a form-locking manner via this outer contour onto the housing of a secondary locking mechanism.

In the following, the term enclosed is not be understood in such a way that a layer which encloses another layer in the cable buildup necessarily touches the other layer. Rather,

between two layers, one of which encloses the other, an intermediate layer may also be situated.

In the following, plug connectors are to be understood as electrical couplings, which may take the form of plugs as well as sockets.

Advantageous developments of the present invention are found in the dependent claims.

Further details and advantages of the coaxial cable according to the present invention and of the corresponding manufacturing method are derived from the following description of an exemplary embodiment with reference to the enclosed figures.

The figures show:

Figure 1 a longitudinal section view of a coaxial cable in a first manufacturing step,

Figure 2 a longitudinal section view of the coaxial cable in a second manufacturing step,

Figure 3a a longitudinal section view of the finished coaxial cable,

Figure 3b a front view of the finished coaxial cable.

Figure 1 shows a longitudinal section view of a coaxial cable at the beginning of manufacture. The monopole coaxial cable has a core 1, which is made up of an inner lead 1.1 and an inner contact 1.2. Inner lead 1.1 in turn is made up of seven wires and is enclosed by an electrically nonconductive dielectric 2. This dielectric 2 in turn is enclosed by a

shield 3, two-layer shield 3 including an electrically conductive foil 3.1, made of aluminum in the exemplary embodiment presented and a metal braid 3.2. These two layers of shield 3 are enclosed by a jacket 4, which represents at the same time the outer layer of the coaxial cable and is made of a PVC-based material. Prior to the attachment of a plug connector, shield 3 and jacket 4 are cut to length in such a way that dielectric 2 protrudes with respect to shield 3 and jacket 4. Furthermore, inner lead 1.1 protrudes from dielectric 2.

First, a mechanical and electrical contact is established between inner contact 1.2 and protruding inner lead 1.1 using a crimp connection. On account of the sectional view, the plastically deformed holding arms of inner contact 1.2 which partially embrace inner lead 1.1 are not visible in the figures.

The plug connector, a socket in the exemplary embodiment shown, includes a one-piece electrically conductive contact sleeve 5 made of metal, which is made, among other things, of an essentially hollow cylindrical segment 5.1, the outer surface 5.3 of which was roughened by placing prick-punched points. Alternatively, roughening may also be performed by notching, ribbing or knurling. Furthermore, contact sleeve 5 has a widened subsection, into which a plug may be inserted following assembly. An insulator 5.2 made of plastic is located within the widened subsection. The wall thickness of contact sleeve 5 decreases toward the end that lies across from the widened subsection. This conical form, which is achieved by a beveled turning of the outer surface of the corresponding end of contact sleeve 5, results there quasi in a ring-shaped circumferential cutting edge.

In the course of the assembly or the preparation of the coaxial cable, contact sleeve 5 is slid onto the protruding dielectric 2. For this purpose, the inner diameter of contact sleeve 5 is dimensioned in the corresponding contact area in such a way that contact sleeve 5 can be shifted radially without play on dielectric 2 in the axially parallel direction X.

Subsequently, contact sleeve 5 is pushed in or inserted in the axially parallel direction X between shield 3 and dielectric 2. In the process, the inner surface of the first segment 5.1 of contact sleeve 5 slides on the outer surface of dielectric 2 such that dielectric 2 acts as a guide for sliding contact sleeve 5. The outside of segment 5.1 of contact sleeve 5 slides along foil 3.1, foil 3.1 being partially pushed together as a consequence of the shearing forces produced.

Metal braid 3.2 and jacket 4 are slightly flared in the respective region. This deformation produces radially directed forces that press shield 3 against contact sleeve 5 such that foil 3.1 or metal braid 3.2 securely contact contact sleeve 5 in an electrically conductive manner. Furthermore, the roughened areas or prick-punched points of the outer surface of segment 5.1 of contact sleeve 5 achieves a higher holding or pull-off force of contact sleeve 5.

The use of smooth foil 3.1 as a component of shield 3 at this point has the advantage of allowing for a convenient and simple insertion of contact sleeve 5 with respect to shield 3. Foil 3.1, however, has advantages not only with respect to assembly, but is also provided in the cable structure to act as an additional shield attenuation in the operation of the coaxial cable.

The measures described above, particularly the protrusion of dielectric 2 and the use of foil 3.1 as contact layer with respect to contact sleeve 5, simplify assembly and significantly reduce assembly time.

Following the insertion of contact sleeve 5 between shield 3 and dielectric 2, contact sleeve 5, according to Figure 2, thus on the one hand encloses dielectric 2 in a segment 5.1 while on the other hand being enclosed by shield 3. In this exemplary embodiment, contact sleeve 5 contacts both metal braid 3.2 as well as foil 3.1. At the same time, sliding contact sleeve 5 in the X direction also inserts inner contact 1.2 into the central bore hole of insulator 5.2.

In the next manufacturing step, an injection molding process is used to apply an insulating material, in the shown exemplary embodiment a fiberglass-reinforced PP material, as extrusion coat 6 around jacket 4 and contact sleeve 5. In the process, extrusion coat 6 adheres excellently to contact sleeve 5 made of metal and jacket 4 which, as already described, is based on a PVC material. After cooling extrusion coat 6, a very good mechanical bond of the extrusion-coated parts has thus been achieved such that extrusion coat 6 acts as a strain relief of the contact between segment 5.1 and shield 3 or that contact sleeve 5 is fixed relative to shield 3 in the sense of a strain relief. For this reason it is not necessary to provide any other measure or device for strain relief. In particular, a crimp connection can be dispensed with in this location, which markedly decreases the assembly time and at the same time reduces the number of the parts of the coaxial cable, which significantly reduces the total expenditure for manufacturing a coaxial cable having a plug connector.

Extrusion coat 6 is geometrically designed in such a way that ribs 6.1 running around the outside are provided. The outer contour of extrusion coat 6 accordingly has in places offset in the axially parallel direction X different distances r, R with respect to inner lead 1.1 or to core 1. In the shown exemplary embodiment, extrusion coat 6 acts not only as a strain-relief element, but also for receiving a housing. Such a housing is used in order to keep a connection of two plug connectors securely together. For this purpose, axially parallel forces (parallel with respect to X) must be able to be introduced into the respective cables. These forces are transmitted by keyed connection between a housing of a secondary locking mechanism not shown in the figures and extrusion coat 6. Ribs 6.1 are thus used for the form-locking transmission of axially parallel forces, the connection between the housing and the coaxial cable being torsion-free.

Such a coaxial cable having a plug connector is particularly suited for use in motor vehicles for transmitting high-frequency signals such as antenna signals, for example, in the range of 4 GHz. Due to the construction, particularly due to the sealing and mechanically stress-resistant extrusion coating, the coaxial cables according to the present invention are especially robust and of high quality.

Incidentally, the present invention is not limited to coaxial cables whose plug connectors are oriented in extension of core 1 or along axis X, but it also includes coaxial cables having an angled plug connector.